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Does Exchange Rate Variation Effect African Trade Flows?

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Abstract

This paper examines the effect of exchange rate volatility for a set of three African countries: Malawi, Morocco and South Africa to aggregate exports during the period of 1973: q1-1990:q1. It is claimed by some researchers that exchange rate volatility causes a reduction on the overall level of trade. Empirical researchers often utilize the standard deviation of the moving average of the logarithm of the exchange rate as a measure of exchange rate fluctuation. In this study we propose a new measure for volatility. Overall our results have suggested significant negative effects from volatility on exports for all the countries in our sample when a measure of unexpected fluctuation was used.

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Keywords: Exports; sectoral exports; E.U.; Exchange Rate Volatility

1.1 Introduction

The collapse of the Bretton Woods regime signaled a new era in economic history resulting to a switch from fixed to flexible exchange rates system for most economies. Whilst some economists embraced this transition others cautioned about the effect that free floating exchange rates could impose to a country's exports. Their augment centered to the notion that unexpected changes of the exchange rates would impose a

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negative impact to the exports of risk averse producers and cause them to switch sales to the domestic markets which will in turn cause a reduction on the overall level of trade. Despite this view some argue that free floating exchange rates are beneficial for a country's exports. The basic for their argument is that unexpected exchange rate fluctuation would serve as a motive for producers since there is often a possibility for larger profits. As a result of this unexpected fluctuation of the exchange rate will increase exports and promote a country's trade flows. Lastly some suggested that unexpected exchange rate fluctuation can often be hedged by investing into forward market as a result there is an indeterminate or no relation to trade flows.

These different viewpoints have also been supported by the empirical literature resulting to a mixed support with regard the effects of exchange rate fluctuation on exports. Motivated by the lack of extensive literature for African countries, the purpose of this article is to examine whether exchange rate volatility hinders aggregate exports for South Africa, Malawi and Morocco, and also to present a new complexity to the issue in hand through the examination of a new measure of exchange rate volatility.

The remainder of this paper will be organized as follows: First we present a review of the literature, second we discuss various measurement issues of exchange rate volatility, third we present and discuss and define the data, fourth we present the methodological framework, fifth we pressed by presenting the results of the utilized statistical tests, the estimated equations and an analysis of our main empirical findings. Finally in the last section we present some policy implications, a brief summary and our collusions.

2.1 Literature review

The literature on the issue is quite large. An extensive review of the previous theoretical as well as empirical literature is well surveyed in Makenzie (1999). However in this section the main arguments will be survived with an emphasis on key aspects pertaining to this study. Early empirical work by Clark (1973) produced a model which estimates a negative effect of exchange rate volatility to the level of exports although there were many findings of an insignificant relationship between export quantity and volatility (Hooper and Kohlagen 1978). Consistent with the advancements of the time these early studies have been utilizing basic models of exchange rate volatility as well as basic econometric estimation techniques such as OLS.

Early 1980's studies (Cushman, 1983, 1986,1988) examine the effect of exchange rate risk on exports incorporating issues which had not been considered before such as aggregate and bilateral exports as well as different measurement issues of the included variables. Akahtar and Hilton (1984) concluded that exchange rate uncertainty is detrimental to the international trade. Cushman published a series of studies (Cushman, 1983, 1986,1988) in the early-mid 1980's which examined exchange rate volatility to bilateral trade and expended his model by adding additional countries as well as different measures of exchange rate volatility. De Grauwe (1988) produced a model which incorporated the percentage change of export quantity as a measure of volatility. The average absolute difference between the previous forward rate and the current spot rate has been proposed by Peree and Steinher (1989) as better indictor of exchange rate volatility to bilateral exports. Despite the examination of some additional issues for the most part the empirical literature has produced a range of results which include positive, negative as well as indeterminate or no effects form volatility to exports.

In an attempt to do derive more accurate relationships researchers are starting to utilize new empirical statistical methods in the 1990's. These new statistical techniques include ARCH-GARCH, ECM and VAR models in order to account for statistical properties of the samples. The estimation of more accurate relationships results to less focus given towards the measure of volatility causing the range of the estimated the range of results still remain the same as in the 1980's. Several studies found support for the hypothesis of

a negative relationship (Arize 1995, 1996, 1999, 2000) while others identify a positive relationship (Asseery A. and Peel D. 1991) or in some cases no relationship at all (Arize 1999).

In the period from 2000 and onwards similar to the conflicting views on the role of the exchange rate risk, the results from available empirical studies have been mixed and sometimes ambiguous. Although for the most part exchange rate volatility is measured as the moving average of the log exchange rate some variation some researchers have tried to utilize additional measures. Awokuse and Yuan, (2006) tried to apply three measures of volatility which included the variance of the spot exchange rate around the preferred trend to sectorial exports and revealed mixed effects. Reflecting earlier research in the general literature the empirical estimation methods still remain ECM or ARCH-GARCH estimation techniques. However, some empirical researchers try to expend their samples. Kargbo (2006) developed a model examining the exports and imports for agricultural products while Benson O. and Godwin A. (2010) examined the effects of exchange rate volatility in the CFA (communaute financiere Africaine) and non CFA countries of Africa. The range of the estimated relationships between exports and exchange rate volatility remains the same as in the previous periods.

The results of the previews research can be viewed with caution because of three problems. First the early 1970's, 1980's as well as some early 1990's studies relay mainly to the OLS methodology which proves to be inadequate to cope and account with some of the statistical properties that the samples often may contain such as unit roots and cointegration. As a result of this inadequate estimates might be obtained. Second the empirical research has provided limited or no evidence of the effects of exchange rate volatility on exports for the South American countries. Finally, for the most part the empirical research uses the standard deviation of the moving average of the logarithm of the exchange rate as a measure of exchange rate volatility leaving only very small amount of empirical research which examined alternative measures of volatility.

3.1 The Model

The model underling the empirical analysis is that of Golstain and Kahan (1976) which has been extended in such a way to account for volatility as well as seasonality effects. The model can be summarized by the equation 1.1

$$log(X)= \lambda 0+\lambda 1*log(PX/Pw) +\lambda 2*log(GDP)+\lambda 3 +\lambda 4*(V) + \lambda 5*D1+ \lambda 6*D3 + \lambda 7*D4 + \lambda 8*T + \omega \quad (1.1)$$

Where:

- X is export quantities,
- PX/Pw the relative prices,
- GDP real world GDP,
- V volatility (defined as the standard deviation of the moving average of the logarithm of real exchange rate), as well as a dummy capturing high and low peak values of the real effective exchange rate
- D1, D3, D4 seasonal dummies
- T time trend
- ω an error term

The real export value is created using the unit value method. Our first explanatory variable is relative prices and it is constructed by the division of the export price of each sector over an index comprised of world export prices for each corresponding sector. The second right hand variable is real domestic GDP serving as a measure of competitiveness. The third right hand variable is volatility which is measured in two ways. Firstly,

as a measure of time varying exchange rate volatility, we use the standard deviation of the moving average of the logarithm of real effective exchange rate. Secondly, as a measure of high and low fluctuation above the average values of volatility, we utilize a dummy variable capturing high and low peak values of the real effective exchange rate for each sectoral trade flow. Our estimation of each of the reduced from export equations for each country will be consistent with the vector error correction methodology (V.E.C.M.) and will impose the restriction of three endogenous variables and five exogenous.

3.2 Exchange rate volatility measurement

One of the most fundamental issues of the topic in question is the volatility measure. Exchange rate volatility is a measure that is not directly observable thus; there is no clear, right or wrong, measure of volatility. Most empirical studies have utilized the standard deviation of the moving average of the logarithm of the exchange rate.

$$V_{t+m}=[\frac{1}{m}\sum_{i=1}^{m}(R_{t+i-1}- R_{t+i-2})^{\wedge}2]^{\wedge}\frac{1}{2}$$

Were:

R is the nominal or real effective exchange rate

M is the number of periods which usually ranges between 4-12

Having previously worked with such a measure (the standard deviation of the moving average of the logarithm of the exchange rate) it is obvious that there are some benefits from the usage of such a measure. However, despite the benefits there are as well as some drawbacks. The main criticism for the application of such a measure is that it fails to capture the potential effects of high and low peak values of the exchange rate which, according to some economic models these high and low values refer to the unpredictable factor which affects exports. Our investigation will be composed of two sets of estimated equations. The first contains the standard deviation of the moving average of the logarithm of the real effective exchange rate as a measure of volatility. The second is a dummy variable which captures the values above and below the average value of the exchange rate. In order to derive the true variance for each one of these values the average value of the exchange rate has been removed. Since for each country different values affect exporter's behaviour, various cases are examined for which the exchange rate fluctuated above and below its average value from 5% to 7%. These ranges might be different for each country; therefore, only the first significant cases obtained irrespective of the percentage used will be reported. In the event that none of these results do not have statistical significance, the cases for which the exchange rate variable is closest to statistical significance will be reported (Serenis et.al 2011; Serenis, Tsounis 2012; Serenis, Tsounis 2013; Serenis, Tsounis 2014).

4.1 The Data

As we have mentioned this study will examine the effects of volatility for three African countries these countries are: South Africa, Malawi and Morocco. All the data are derived from IFS (International Financial Statistics). All the data will be collected quarterly and will extend from 1973: q1-1990:q1.

5.1 Empirical results

This section presents the empirical results. Consistent with the empirical methodology we will utilize the

augmented Dickey Fuller unit root test results. The results of the unit root tests are presented in table 1

Table (1) Augmented Dickey Fuller unit root test results

Country	Variables			
	X	GDP	P	V2
South Africa	I(2)	I(2)	I(2)	I(0)
Malawi	I(2)	I(2)	I(0)	I(0)
Morocco	I(1)	I(2)	I(1)	I(0)

All tests are performed using the 5% level of significance*Vex the export quantity, GDP represents the real gross domestic product, V2 volatility and P is the relative prices of the each country to the world price *All tests are performed to a maximum of three lags using the Akaike info criterion

5.2 Error correction model

The null hypothesis of the ADF tests is that the series is stationary, were as the alternative is that the series is non stationary of order n. In the event that a unit root is present we continue to test for a higher order of integration until we reach a point on which integration is not present. The tests reveal that the test statistic is larger than the critical values for X, GDP and P for at least the first differences. For the most part volatility is not integrated partly do to the fact that it is already differenced. We therefore conclude that all the results of the unit root tests indicate that most of the countries in our sample contain at least one unit root.

We now examine the long run equilibrium relationship between the series using the Johansen- Juselious multivariate procedure for all the two cases examined here (one case utilizing the standard volatility measure as well as three additional ones for which exchange rate exceeds certain thresholds). As we can see in tables 3-4 the null hypothesis of zero cointegration (Ho: r=0) is rejected for the most part by both the trace as well as the maximum eigen value (λmax) statistics for all the cases examined here indicating that at all of the trade flows here contain at least one or more conintegrating relationship as well as a long run effect.

Table 2 Johansen's maximum likelihood test results (R = number of cointegrating vectors) for export equation using the volatility measure 1

	Trace Statistic				Max-Eigen Statistic			
country	r=0 r=1	r<=1 r=2	r<=2 r=3	r<=3 r=4	r=0 r=1	r<=1 r=2	r<=2 r=3	r<=3 r=4
South Africa	51.56314	24.44945	9.512287	0.413407	27.11369	14.93716	9.098880	0.413407
Malawi	53.63650	25.29986	9.452111	1.544925	28.33665	15.84775	7.907186	1.544925
Morocco	65.94992	36.25217	11.55610	0.014469	29.69775	24.69607	11.54163	0.014469
Critical values 5%	47.21	29.68	15.41	3.76	27.07	20.97	14.07	3.76

* Measure 1 refers to the standard deviation of the logarithm of real effective exchange rate.

Table 2 Johansen's maximum likelihood test results (R = number of cointegrating vectors) using volatility measure 2 when exchange rate rise above and below the average value

	Trace Statistic				Max-Eigen Statistic			
country	r=0 r=1	r<=1 r=2	r<=2 r=3	r<=3 r=4	r=0 r=1	r<=1 r=2	r<=2 r=3	r<=3 r=4
South Africa	53.01131	17.90865	7.688634	1.081473	35.10266	10.22002	6.607161	1.081473
Malawi	70.27600	35.22330	16.60567	0.645555	35.05270	18.61763	15.96011	0.645555
Morocco	60.28402	30.42965	9.070366	0.036364	29.85437	21.35928	9.034002	0.036364
Critical values 5%	47.21	29.68	15.41	3.76	27.07	20.97	14.07	3.76

6.1 Error correction model

Prior to developing each model the long run relationship among the variables included in equation 1 was tested. In order to implement the Johansen procedure a unit root of order one or higher should exist among at least one of the variables of each trade flow. As it is evident from the previously presented tests (tables 1 and 2) all of the variables in our equation contain at least one unit root of order no higher than one. The next step is to apply the Johansen to the data. The test utilizes the trace static as well as the max eigen statistic and compares them to the critical values. In the event that ether one of these or both of these values exceed the critical values the test indicates a cointegrating relationship. Recognizing that the type of cointegration tests are very sensitive to the underlining model specification for example the number of lags as well as the treatment of some of the variables (endogenous or exogenous variables) it is assumed that all the I(1) variables contain at least one cointegrating vector (since each trade flow contains at least one cointegrating relationship). With all these in mind it is evident that a vector error correction model can be applied in all of the cases examined here. The results for each volatility measure are presented in tables 3-4.

Table 3 Vector error correction model

country	LAG	VEX	C	GDP	P	V1	ECT	statistics
South Africa	0		-0.48418 (-2.7178)				-0.226190 (-2.71235)	**R2**= 0.39936 **DW**=1.97366 **Serial corl F[4, 64]**= 0.772725 **ARCH F[4,64]**= 0.840800
	1							
	2	0.25942 (1.7958)		0.50439 (2.4057)				
	3				0.504392 (2.40579)			
	4	0.56680 (3.6551)						
Malawi	0		10.78488 (4.32854)				-1.702324 (-4.13067)	**R2**=0.880536 **DW**=1.91142 **Serial corl F[3, 39]**= 0.060545 **ARCH F[3,39]**= 0.151361
	3			15.9362 (2.4344)	-0.55566 (-2.1122)			
Morocco	0						-2.154211 (-3.81035)	**R2**=0.976435 **DW**=2.190962 **Serial corl F[3, 120]**= 0.303242 **ARCH F[3,120]**= 0.950482
	1	-5.535406 (-3.8389)						
	2			9.78084 (2.0846)	0.259562 (1.34308)			

Table 4 Vector error correction model measure 2

country	LAG	VEX	C	GDP	P	V2	ECT	statistics
South Africa	0		-1.161058 (-2.7806)			0.002353 (2.31879)	-0.845962 (-2.74582)	**R2**= 0.605216 **DW**=2.034076 **Serial corl F[9, 62]**= 0.054648

								ARCH F[9,62]= 0.950432
	2	0.450871 (2.09743)			0.530270 (1.81532)			
	4	0.608973 (3.05107)		-3.0986 (-1.516)				
	5				0.612913 (1.60042)			
	6				0.582486 (1.57891)			
	8			3.90543 (2.0826)				
	9			3.78559 (2.0623)				
	10							
Malawi	0		10.13667 (4.51223)				-1.881367 (-4.31011)	**R2**=0.882398 **DW**=1.912405 **Serial corl F[3, 39]**= 0.112178 **ARCH F[3,39]=** 0.200186
	1	0.503676 (1.45499)						
	3			17.7423 (2.7128)	-0.51821 (-1.9865)			
Morocco	0		1.799027 (2.26950)				-0.879821 (-1.54950)	**R2**=0.982666 **DW**=2.436730 **Serial corl F[3, 25]**= 0.090433 **ARCH F[3,25]=** 0.247520
	1				-0.48752 (-1.8595)			
	2			9.87219 (1.7948)				

* For all of the tables vex is the export quantity, GDP represents the real domestic gross domestic product, V1 and V2 volatility using measure 1 and measure 2, ECT represents the error correction term, C the constant and P is the relative prices of the each country to the world price. * For table 3 V1 is defined as the simple standard deviation of the log effective exchange rate and 4 lags were used for South Africa, 2 for Morocco and 3 for Malawi. * For table 4 volatility represents the values of 15% for Malawi, 3% for Morocco and South Africa above and below the average value of the exchange rate using 3 lags for Malawi and Morocco and 9 for South Africa * T statistics are in parenthesis.

Considering the regressand results of tables 3-4 the empirical results suggest that the statistical fit or each model to the data is satisfactory as indicated by the values of R^2. Moreover the statistical appropriateness of all the equations fulfils the conditions of serial nocorelation (for both the serial correlation LM test as well as the ARCH test) and is supported by all of the diagnostic tests.

Further more through the examination of the results several observations can be made. First the error correction term is statistically significant and displays the appropriate negative sign. Second the dynamics of the equations show for the most part that changes in real income (GDP) and relative prices both have significant effects on exports. Third, all of the cases examined here have been tested for joint significance of all the dependent variables (using the Wald test). The results of the test reveal a short run effect in addition to the long run effect. Fourth a closer examination of the focus variable, volatility, reveals that none of the cases examined here utilizing a moving average measure of volatility was proven to be significant. However, for the cases for which the rise above the average value of the exchange rate has been used as a measure of volatility the results appear to have more statistical significant cases. The results therefore suggest that (for the second measure) there is one significant case for South Africa and with a positive coefficient.

The results of this article add to the literature in several ways. First, as we pointed out in the beginning of this paper our investigation of the literature has uncovered limited empirical work concentrating on the effects of volatility to exports for African countries. Second, as identified in the literature review there is a variety of differences among empirical researchers on the effects of volatility to exports. The reason for such differences can be attributed to differences among measurement of variables, samples and statistical techniques. In this study we have concentrated on the most important issue overlooked by empirical research the exchange rate measure. It is often clamed by some empirical researchers that the peak high and low values of the exchange rate do have an important effect on the level of exports since often they effect the profits of the exporters much greatly. Although a limited amount empirical work has tried to examine this view for the most part researchers tend to utilize the logarithm of sample standard deviation as a measure of volatility. This measure although provides many advantages it falls encapsulate the potential effects extremely high or low values of the exchange rate on the level of exports. As a result of this in addition to the common measure of volatility we have tried to calculate a new measure capturing extreme fluctuations between 5% - 7% of the average value of the exchange rate while at the same time removing from these the average value of the exchange rate.

6.2 Summary conclusion and policy implications

In this study we have taken explicit account of non-stationarity and have applied a multivariate cointegration error correction model for three African countries and two different measures of volatility. Each model satisfies several commonly utilized econometric tests in the analysis of time-series data such as cointegration and unit roots. Our empirical analysis suggests that although exchange rate volatility when measured as the simple standard deviation of the log effective exchange has no effect on the level of exports for the South American countries. However, when alternative measures are used which capture the effects on high and low values of the exchange rate, which can be considered responsible for the changes in exports, there is an indication of a stronger effect from movements of the exchange rate to the level of exports. As a result of this we find an over all significant statistical relationship which for the most part suggests a positive relationship between exports and exchange rate volatility. From a policy prospective our results are important. They suggest that policy makers should consider volatility for some but not all countries when applying economic policy. More specifically, policy actions reducing unexpected fluctuation of the exchange rate, for one of our sample countries, will reduce the exported amount. The actual reduction from such a policy is beyond the scope of this paper and will be addressed in future work. However as we have proved ignoring the unexpected effects of exchange rate could result in miscalculations of the exported amount for south Africa.

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